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EXPERIMENTAL INVESTIGATION OF BEHAVIOUR OF FIBER REINFORCED CONCRETE PILE IN MEDIUM DENSE SAND

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ABSTRACT

Piles are broadly used for handling vertical axial load sand lateral horizontal loads for various structures like tall buildings, electricity power lines, power stations, offshore structures, highway platforms and railway structures. The performance of the pile is presented by its lateral load – The bending moment profile along the pile shaft and the pile head displacement reaction. A correction factor for the lateral load capacity and the maximum bending moment is calculated using the load-deflection and bending moment behaviour. The role of material property in the behaviour of piles is studied. The pile diameter of 250mm with a height of 1m is used for the experimental study. The recon fibre ratio is decided as 1% based on prior experiments. The main purpose of the paper is to establish the interaction between the soil structures by the use of FRC pile. The material property has been studied and the pile is tested under loading conditions.

KEYWORDS: Pile, Bending Moment, Recron Fibre & Soil Interaction

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Original Article

INTRODUCTION

Piles are used to shift the loads from the structures built to soil or rocks which has high bearing capacity. Few instances, piles are used as foundations including high-rise buildings, oil rigs, flyovers, piers and dams, defense structures, electricity pylon, jetties and quays and retaining structures. Aside from the axial force that the piles bear, these structures subject the piles to lateral stresses and moments. The main purpose of lateral loaded piles is to transfer load to the earth. lateral forces that the piles are designed to withstand are caused by wind gusts.

Various studies have been made on the consequences of soil-based structure interaction problems. It is a requisite fact that we should learn about the soil interface shear strength to the design and analyze the building structure. The behavior of soil and the behavior of structure are inter-related and mutually dependent in the soil-structure interaction problems. Therefore the analysis of the structure as well as soil is required for solving the corresponding problems.

The present work involves individual inspection of axial pile capacities. An effort has been made to study the behavior of single model strengthened concrete piles in medium dense sand, put through assorted inclined load until non-performance with the angle of applied load that differs from 0° to 90°from the vertical axis of the pile. It is done through an experimental model analysis.

REVIEW OF LITERATURE

1) "Nonlinear behavior of reinforced concrete (RC) and steel fiber added RC (WS-SFRC) model piles in medium dense sand" (Cihan Taylan Akdag and Gurkan Ozden, 2013)

In this study, a probe was inserted into thick sand. Steel fibres' impact on non-linear RC pile response was explored in particular. Five kinds of model piles were experimented under lateral loading and lateral-axial loading. The assessment of model piles with and without shear boosting is done under RC- with bending reinforcement pile tests. Tests were conducted on concrete and steel fibre reinforced concrete piles to notice the effect of steel fibres by segregating them from bending and sheer reinforcement. The steel fibre volume ratio was decided as 1% in reference to prior experience. Bending tests were conducted on flexural elements to attain the moment-curvature relationship before the model pile tests. The results of the test showed that the RC-with steel fibre pile behavior is greater than the conventional RC pile under axial loading and distinct rate of loadings.

2) "A method to compute the non-linear behavior of piles under horizontal loading" (Gianpiero Russo, 2016) –2016; 56(1):33–43, The Japanese Geotechnical Society. Production and hosting by Elsevier B.V.

Firstly review was made on the empirical evidence for vertical piles beneath lateral or horizontal loading. The load–deflection relationship is non-linear from the initial stages of flooding, while the load–moment relationship is almost linear moving from the available experimental evidence. The quintessential design issues were met and wide spread Brooms' method was verified. In order to anticipate the pile-soil interaction, a computer code called "NAPHOL" was presented on the basis of hybrid BEM approach. A limiting pressure profile was coupled with a cut-off procedure to deal with the nonlinear behavior. Based on the back-analysis of a crucial number of case records, easy guidelines and equations to calibrate the model were followed and the parameters were derived. The program is eventually used to have its sight set on the pile mechanism-soil interaction under lateral loading. The major design issues for piles under lateral loading have been scanned and a constructive examination of the extensive method for computing the final load capacity has been accomplished. The program is eventually used to have its sight set on the pile mechanism-soil interaction under lateral loading. The major design concerns for piles under lateral loading have been scanned, and a constructive examination of Broms' thorough approach for calculating the final load capacity has been completed satisfactorily.

3) "Experimental Study on Behavior of Recron Fibre Reinforced Concrete" International Journal of Scientific & Engineering Research, Volume 7, Issue 12, ISSN 2229-5518.

The usage of conglomerate cement has increased dramatically in recent years, owing to challenges posed by the professoriate in applying resources that are readily available. The unique additives Recron 3s, which have been attempted in recent years without scientific observation, have been determined to be adequate, however, more work remains to be done in order to sort the qualities of the mentioned additives.

The current study looks into the effects of these additives on the compressive strength and splits tensile strength of cement concrete. The primary goal of this research was to look at the effects of recron 3s additions (fibre). The strength attributes of concrete (M30) are used with different percentages of additives to give specific proportions by adding Recron fibre in the percentages of 0 percent, 0.5 percent, and 1 percent to the concrete mixture and studying variations in strength, strength gains, and workability parameters. New additions are employed as concrete materials in this study, and an attempt is made to analyse the impacts on M30 grade concrete. The scope of work is limited to determining the properties of

concrete in compression and tension, with positive findings.

4) "Application of Recron 3s Fibre In Improving Silty Subgrade Behaviour" IOSR Journal of Mechanical and Civil Engineering, Volume 12, Issue 2 Ver. VI (Mar - Apr. 2015).

The purpose of this study is to see how effective Recron 3S fibre is at improving the soil subgrade strength of Kurukshetra's regional silty soil. For this, a variety of tests were conducted, including Modified Proctor Compaction, California Bearing Ratio (CBR), and Unconfined Compressive Strength (UCS).In total, four soil-fiber mixture samples were prepared, with fibre content of 0.15 percent, 0.30 percent, 0.45 percent, and 0.60 percent of the dry weight of the soil. Other testing for index and physical qualities of parent soil included Atterberg limits, Specific gravity, and Sieve analysis. The investigation revealed that adding Recron 3S fibre to the silty soil increases the CBR and UCS values. It is also clear from the data that also noted that benefit 8 is significant at lower percentage of Recron 3S fibre i.e. 0.15% as compared to higher percentage.

5) "Study on Properties of Concrete Using Recron 3s Fiber" International Journal of Science Technology & Engineering, Volume 4, Issue 3, September 2017.

Concrete is made up of fine and coarse materials that are bound together by cement and combined with water. Due to its inherent character, concrete has become crucial and well-known, resulting in a revolution in the usage of concrete. Concrete offers a plethora of inventive applications, design possibilities, and building methods. Its wide range of variability and relative economy in meeting a wide variety of needs make it a competitive building material. For M25 and M40 grade concrete cubes, prisms, and cylinders, the workability and strength qualities of concrete with Recron 3s fibre in proportions of 0 percent, 0.2 percent, 0.3 percent, and 0.4 percent are observed and investigated. Recron3s Fibre Reinforcement Systems can provide solutions for Recron 3s fibres, which are designed microfibers with a unique "triangular" cross-section and are used in secondary concrete reinforcement. It links structural steel to strengthening concrete's resistance to contraction cracking and improving mechanical qualities such as split/flexural tensile and transverse strengths, as well as achieving the necessary development in abrasion and impact resistance. The current study uses the Compaction factor test, Vee-bee time test, and slump cone test to examine the workability parameters of M25 and M40 concrete grades. Each grade of concrete cubes, cylinders, and prisms were cast for each proportion for strength criteria for a period of 7 days, 28 days, 56 days, and 91 days.

6) ***"A Review on Fiber Reinforced Concrete" International Journal of Civil Engineering and Technology (IJCIET) Volume 7, Issue 6, November-December 2016.***

Concrete is an important building material all around the world. However, disadvantages such as delicacy, weak tensile strength, poor resistance to impact strength, low ductility, fatigue, and low durability limit the utility of concrete as a structural material. Waste materials from various sectors, as well as admixtures, are currently being added to the mix. In India, almost 300 million tonnes of industrial waste are generated each year as a result of chemical and agricultural processes. These materials pose health risks and are difficult to dispose of. The paper industry produces hypo sludge, a waste product with chemical characteristics similar to cement. As a result, it can be employed as a cost-effective construction cementitious material, reducing the paper industry's disposal and air pollution concerns. Recron 3s is used as "secondary reinforcement" in concrete, capturing shrinkage cracks, increasing impact/abrasion resistance, and improving construction quality. An experimental study on the strength of concrete enclosing hypo sludge and recron 3s fibres will be

conducted in this paper. Hypo sludge must be supplemented at a dosage of 25 percent, 50 percent by weight of cement, and Recron 3s fibres must be added at a dosage of 0.5 percent, 1 percent. In this study, experiments will be conducted on M30 mix and tests like flexural test, compression test, split tensile test including porosity and capillary tests. Ultimately, the results of fiber reinforced concrete and conventional concrete is compared.

Physical Design of FRC Piles with Improved Core

In this paper, a discussion is made on the importance of modeling soil–pile interaction in response to Fiber reinforced concrete (FRC) piles and reinforced concrete pile (RC). A displacement-based, RC beam–column fiber model with dispersed lateral deformable supports is exhibited first. Because the bearing capacity of a concrete pile is clearly affected by the length of the pile, the pile diameter is often large, and the pile core is not enhanced. To improve the bearing capacity of traditional piles, this research proposes a new type of lengthened-core pile structure. The most recent construction is made out of a longer core-concrete-filled pipe and an FRC pile. In general, hole-guiding in the concrete pile, tube preparation, and the pouring of core concrete into the tube are three essential difficulties in the design and construction of this structure. The effect of granular pile installation on granular deposit changes in loose to medium dense granular deposits is investigated. FRC is the most frequent method for calculating the in situ soil structures. Expressions for altered FRC and RC values for various soils, i.e., different initial FRC and RC values were identified as functions of replacement ratio from the convenient field data. Improvements in the ground are displayed in the form of enhanced or modified initial FRC and RC values versus replacement ratio charts, which can be used later to design the desired degree of treatment for the expected enhancement or for the estimation of improved values of treated ground for various primary states of sands.

The FRC& RC capacity that is estimated from the prior equation is not considered in the effect of time aging on the FRC capacity, remarking that in an earlier platform that was built 30 years in the past and if the calculation is examined, we can locate that it is away from API factor of safety besides environmental condition. The impact of time surely affects the FRC capacity as by usual phenomena. The pile with the covered soil acts as one unit so any supplementary adhesion is not reflected in the calculation. As a result, there is a study carried out to define the functioning of the axial capacity in clay soil with respect to time.

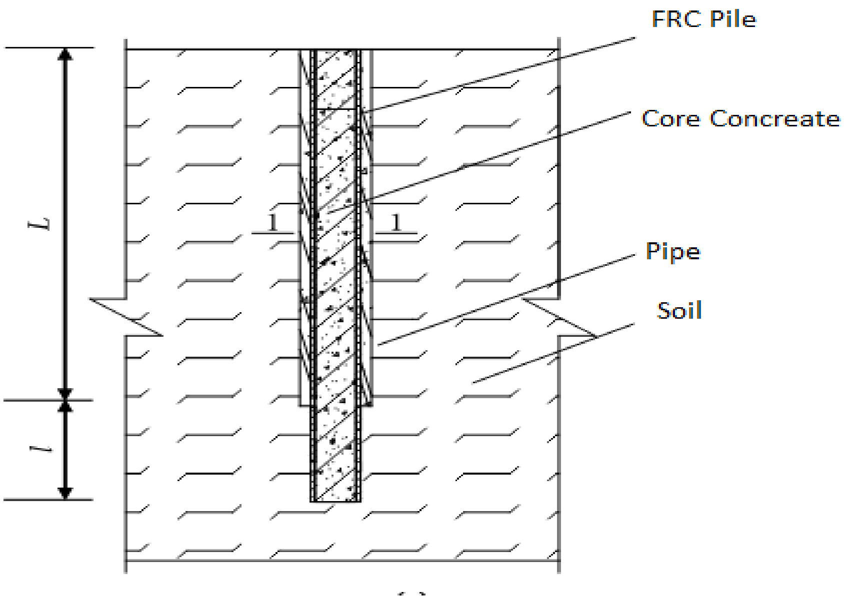

Figure 1: Cross Section of FRC Pile with Lengthened Core-Concrete-Filled Steel Pipe.

Scope and Needs

- The soil structure interaction problems are considered in order to evade the structural failure under the soil structures.
- The responsiveness of distinct pile to the externally applied load is amongst the most complicated soil structure interaction issues in the applied foundation engineering.
- Expecting more precise structural behavior in order to enhance the safety of structures under severe loading conditions
- The soil pile system behavior is largely non-linear and this makes problems sophisticated.

Objectives of the Project

- To examine the behavior of concrete pile in medium dense sand.
- To compare the strength of reinforced concrete pile (RC) and fiber reinforced concrete pile (FRC) to achieve pile deflection.

Experimental Investigation

Detailing of Pile

- Diameter of pile = 250mm
- Length of pile = 1m
- Quantity of materials for pile

Table 1: Mix Proportion

Cement(Kg)	Fine Aggregate(Kg)	Coarse Aggregate(kg)	Water(lit)
40.78	30.64	62.4	18.35
1	0.75	1.53	0.43

Figure 1: Geometry of Pile.

Figure 2: Casting of Specimen.

Figure 3: Loading of Specimen.

Figure 4: Loading setup for Pile Testing.

Figure 5: Cracking Pattern of Pile.

Pile Test Result

Table 2: Test Result For Control Specimen

S.No	Load (kN)	Deflection (mm)	Stiffness (kN/mm)	Ductility	Remarks
1.	69.10	4.89	14.13	1.0	First Crack
2.	94.77	7.50	12.63	1.53	Ultimate Load

Table 3: Test Result For Control + Fiber Specimen

S. No	Load (kN)	Deflection (mm)	Stiffness (kN/mm)	Ductility	Remarks
1.	79.91	7.15	11.17	1	First Crack
2.	145.87	10.87	13.42	1.52	Ultimate Load

Geotechnical Testing Results

Water Content Testing Results

The testing results from the drying method for different soil samples are listed in Table 4. Since the difference in water content of various samples is less than 1%, we take the mean of the two as the final water content, i.e., = 30.5%.

Sample	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Water Content	Average Water Content
Sample 1	50	42.53	30.7	
Sample 2	50	42.27	30.6	30.5
Sample 3	50	42.33	30.3	

Density Testing Results

The testing results with ring knife technique for various soil samples are written in Table 5. Seeing that the dry density difference of the various samples is less than 0.05 g/cm^3, the final dry density is taken as the average of the two, i.e., $\rho_d = 2.24$ g/cm^3.

Sample	Weight of Wet Soil (g)	Volume of Soil(cm^3)	Water Density (g/cm^3)	Dry Density (g/cm^3)	Average Dry Density (%)
Sample 1	121.25	65	2.65	2.25	2.24
Sample 2	121.50	65	2.64	2.23	
Sample 3	121.75	65	2.63	2.20	

Direct Shear Testing Results

The relationship curve between shear strength and vertical pressure is depicted in Figure 5, where the inclination angle of the approximated line gives the friction angle, i.e.,, and the intercept of the ordinate indicates the cohesion, namely, $c = 15$ kPa.

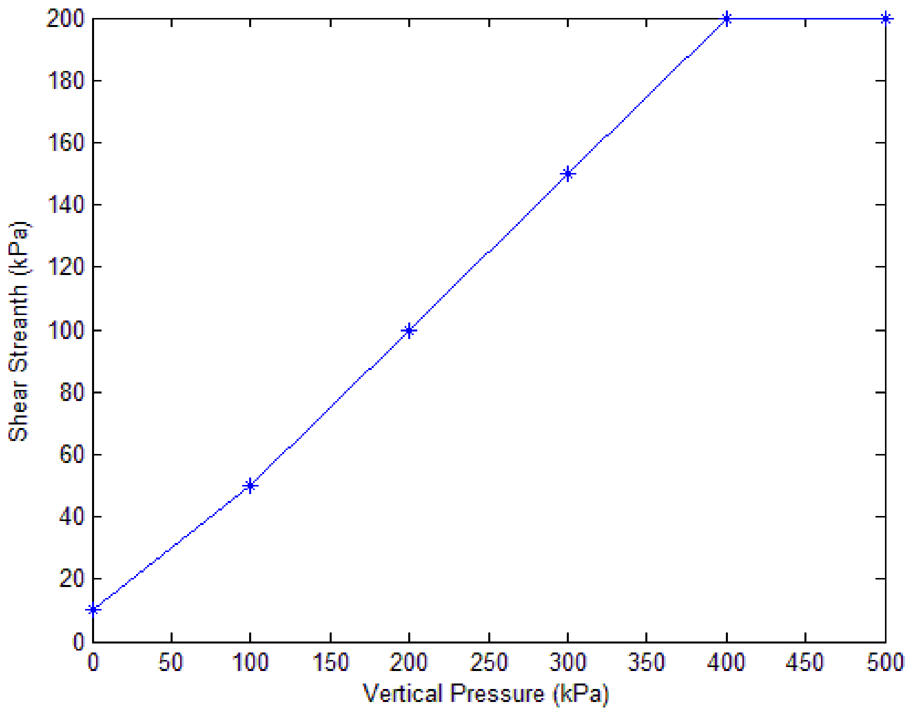

Figure 5: Loading setup for Pile Testing for Pile Testing.

CONCLUSIONS

The behavior of conventional pile and fiber reinforced pile in medium dense sand is analyzed. From the results, it is obvious that the addition of 0.5 % of recron fiber increases the compressive strength of the cube by 33.19 N/mm^2 and split tensile strength of cylinder by 2 N/mm^2. The pile strength attains the maximum of 145.87KN in comparison with the conventional of 94.77KN. The pile displacement substantially rises for the RC pile when compared to the FRC pile

because of cracking, which aggregately leads to a larger variation in the pile deflection due to the axial loading. Owing to loading, the axial load carrying capacity of a pile is progressed in the sandy soil in the ground.

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